

بِسْمِ اللَّهِ الرَّحْمَنِ الرَّحِيمِ

PLC Course

مقرر الحاكومات المنطقية البرمجة

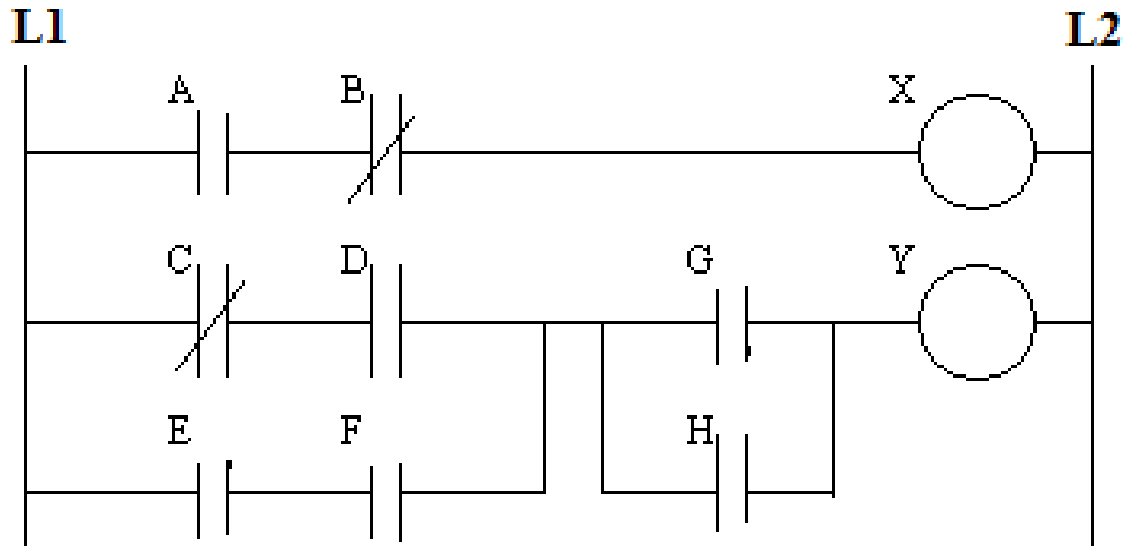
Lec 4

8/3/2016

PLC Ladder Diagram

Quiz

- 1) Convert the following ladder diagram to a Boolean logic expression.

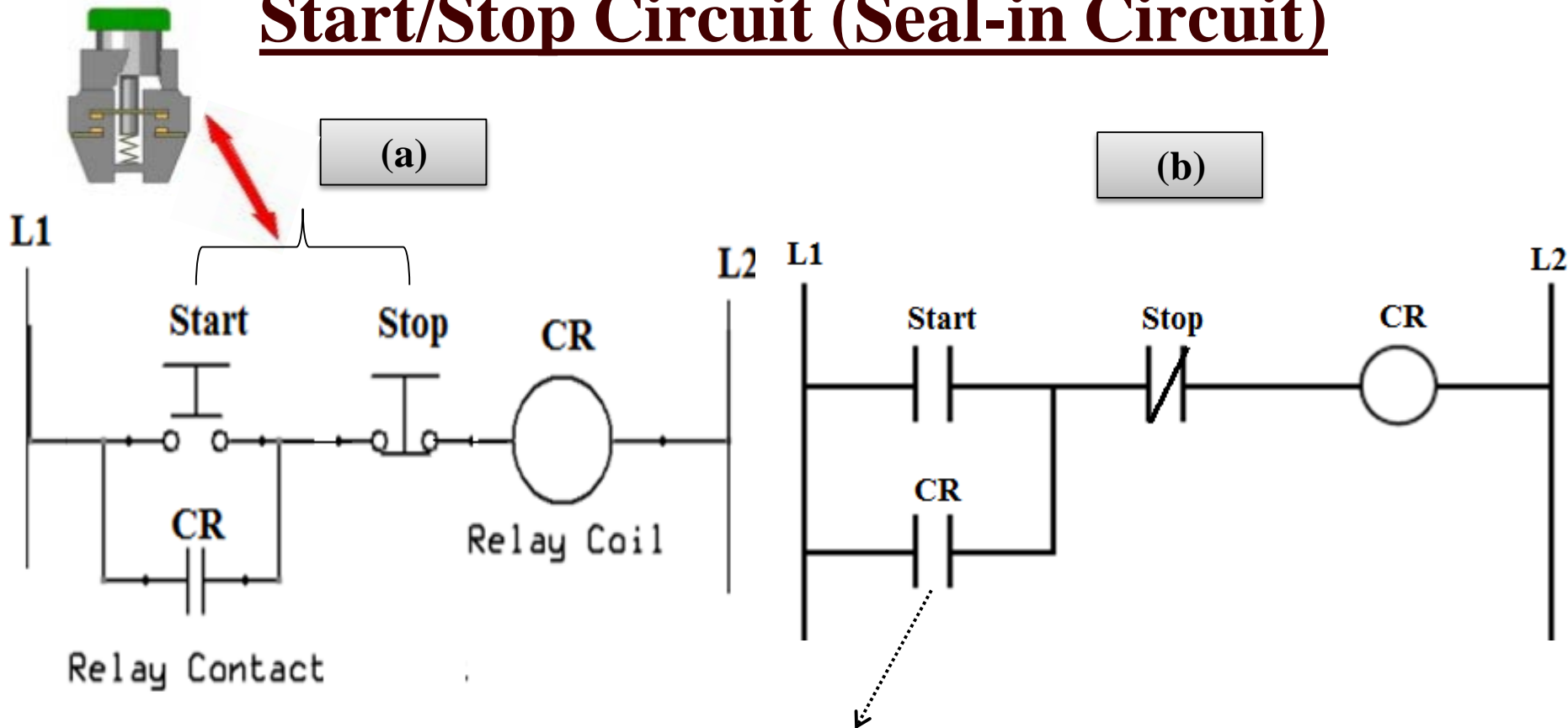


- 2) It's required to use only single push button switch to ON a lamp or OFF the lamp (the push button switch is act as a toggle switch with two functions: on and off)

Start/Stop Circuit (Seal-in Circuit) (Latch / Unlatch Circuit)

- A seal-in circuit is a method of maintaining current flow after a momentary switch has been pressed and released (push button switch) .
- The **stop button** is normally closed and the **start button** is normally open. There is one relay in the circuit consisting of both **a relay coil and a normally open relay contact** (called **seal-in contact** or **auxiliary contact** or **latch contact**).
- When the start button is pushed it allows current to flow through the relay coil and forces the relay contact to become closed. Once the relay contact is closed there is an alternate path around the start button for current to flow so that when the button returns to its open position the current can flow through the contact and around the switch. When the stop button is pressed it interrupts (disconnects) current flow to the circuit and must be restarted again with the start button.

Start/Stop Circuit (Seal-in Circuit)



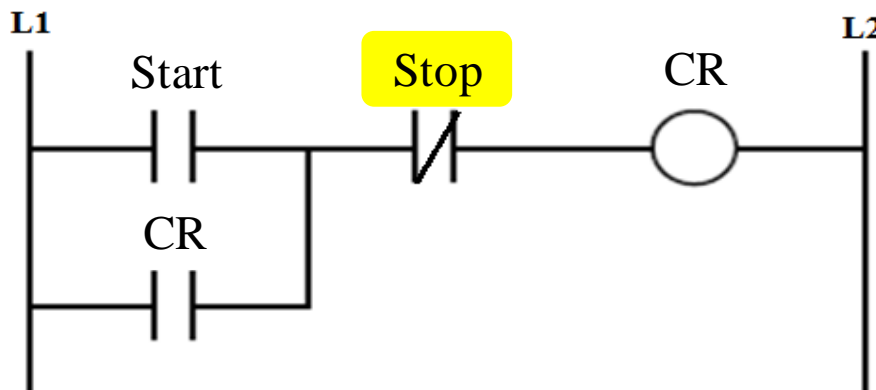
CR contact is called auxiliary contact or seal-in contact or latch contact.

The start/stop circuit:

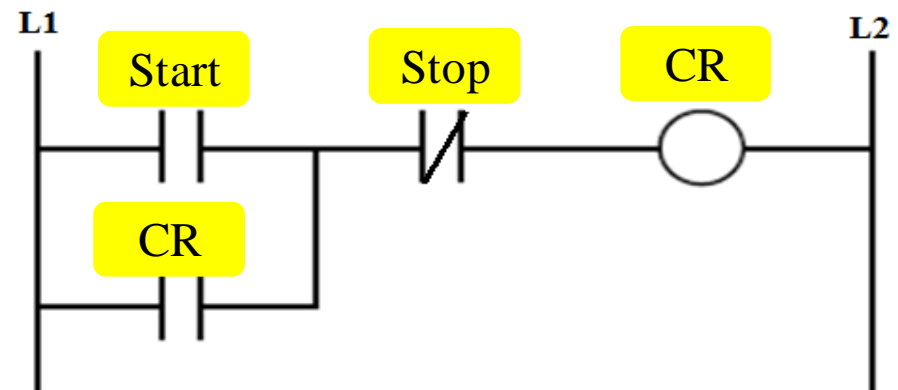
(a) Relay logic diagram

(b) PLC Ladder Diagram

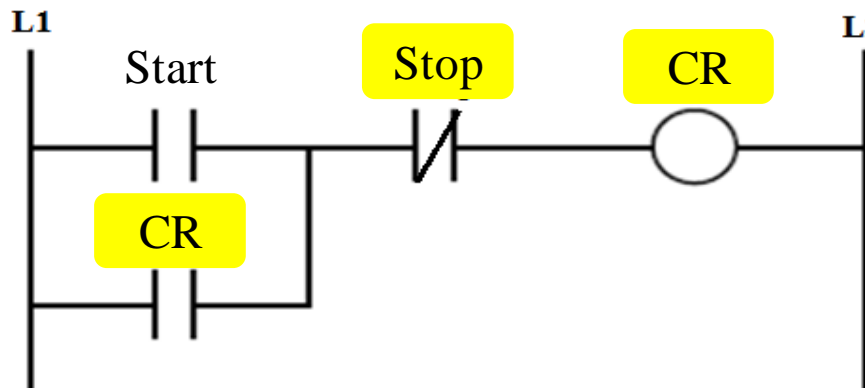
Start/Stop Circuit Operation



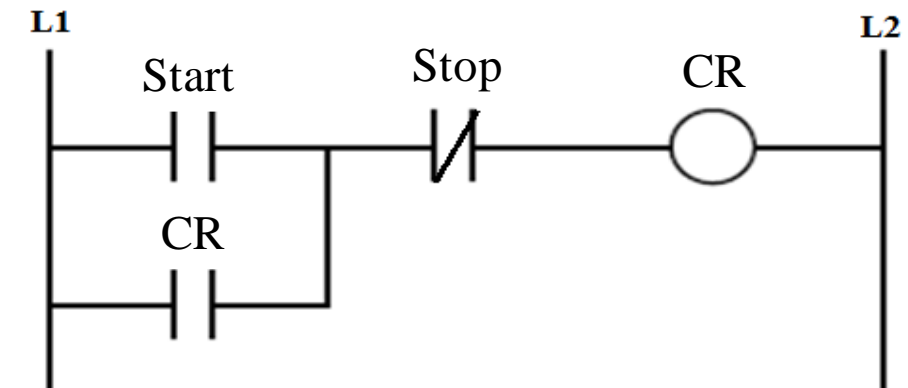
Initial state



Start pushbutton switch is pressed



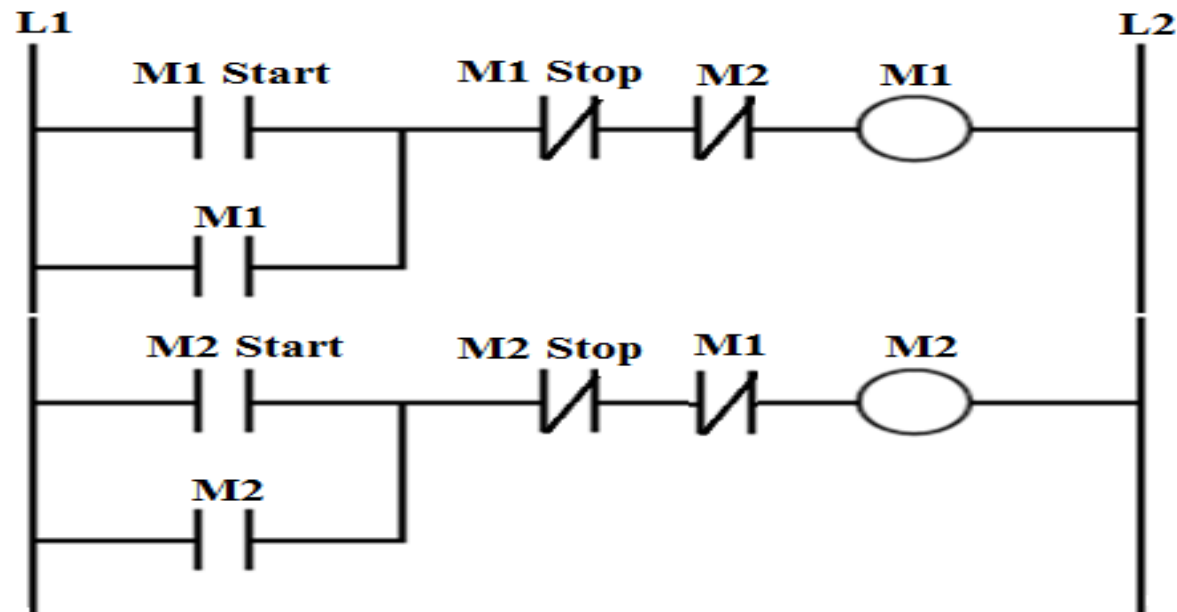
Start pushbutton switch is released



Stop pushbutton switch is pressed

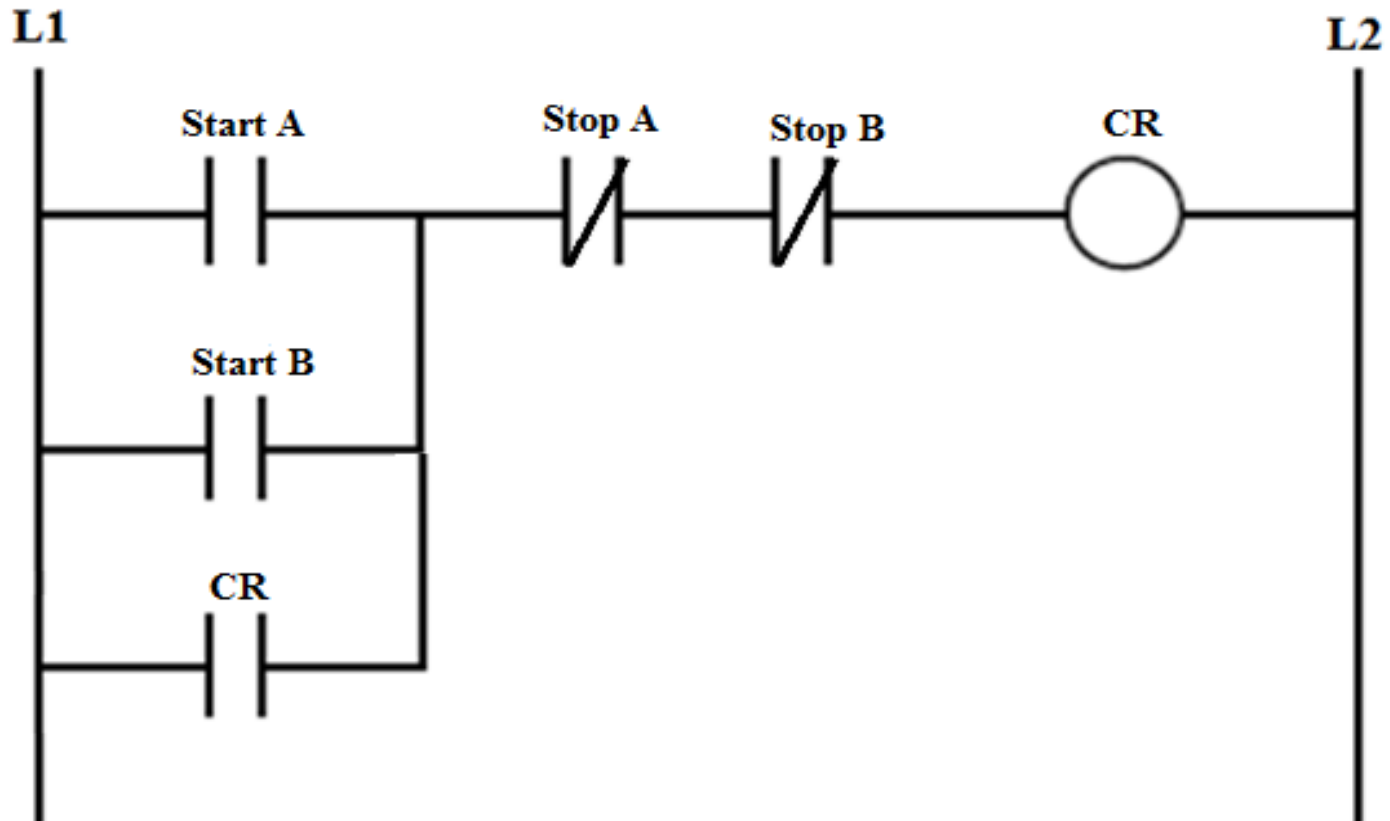
Interlock circuits

- Interlocks (overlaps) can prohibit output(s) from energizing under a certain condition. Example: M1 should not energize if M2 is energized (and vice versa)



Start/Stop Circuit - Seal Variations

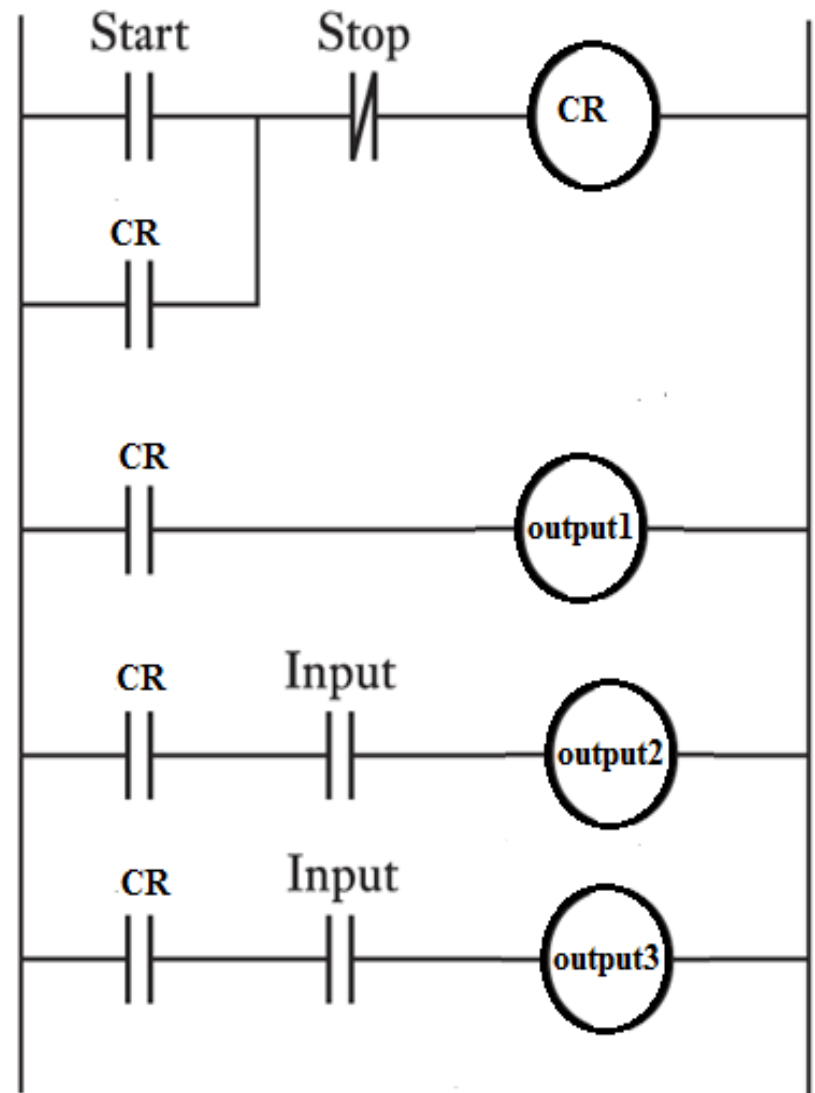
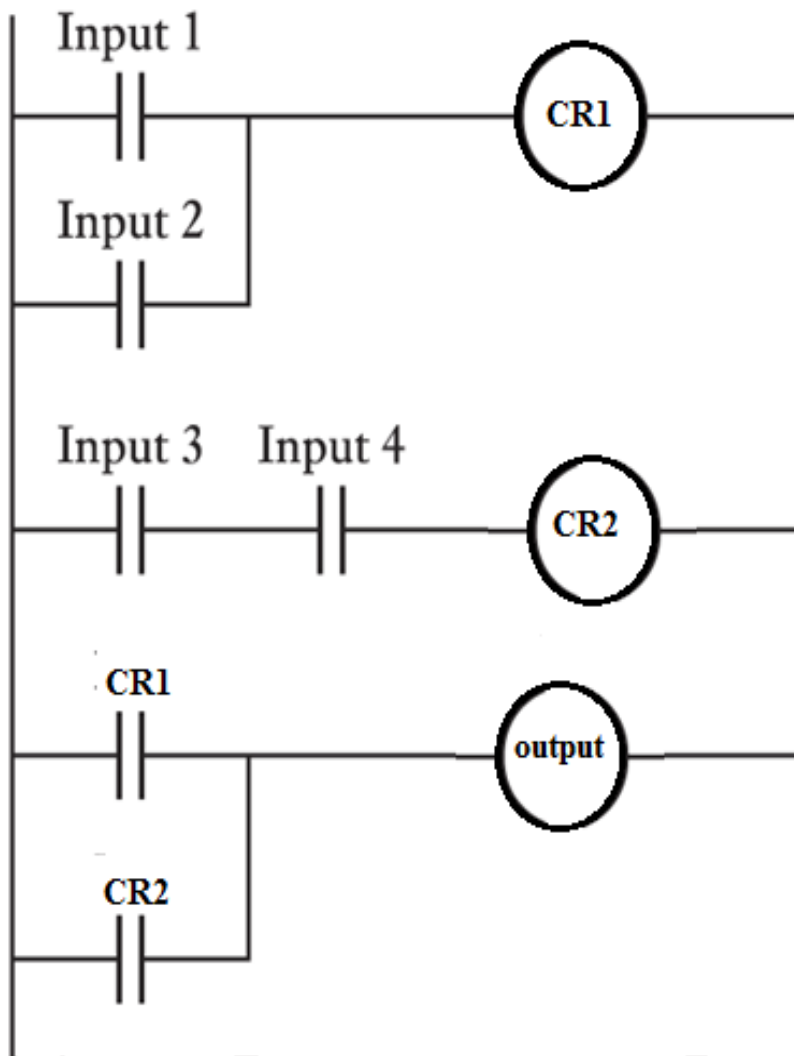
- In practice several start and/or several stop buttons can be used in a process.
- Start buttons (normally open) can be used:
 - ❖ In series if it is required that all be pressed before a process starts.
 - ❖ In parallel if pressing any start button is to start a process.
- Stop buttons (normally closed) are normally used in series if pressing any stop button is to stop a process.



The start/stop circuit with several start / stop buttons

Internal relays

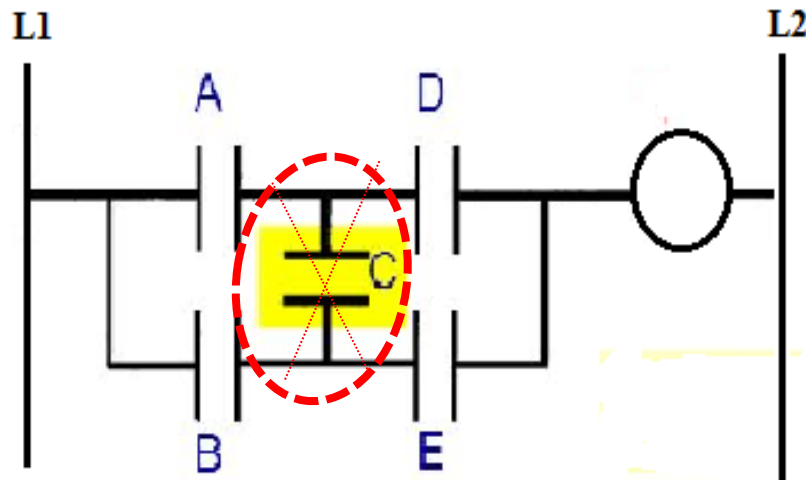
- The term internal or auxiliary relay is used for what can be considered as internal relay in PLC. It behaves like relays with their associated contacts, but in reality are not actual relays but simulation by the software of the PLC (virtual relays).
- Internal can be very useful aids in the implementation of switching sequences.
- They are often used when there are programs with multiple input conditions.



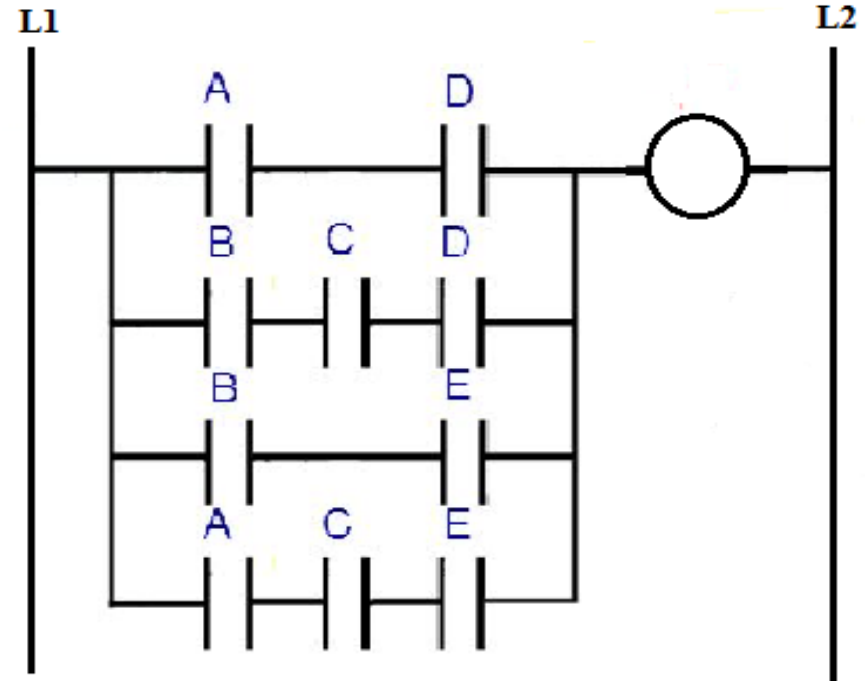
CR , CR1 and CR2 are Internal Relays

Ladder Diagram Programming Restrictions

- 1) Vertical contacts are not allowed.



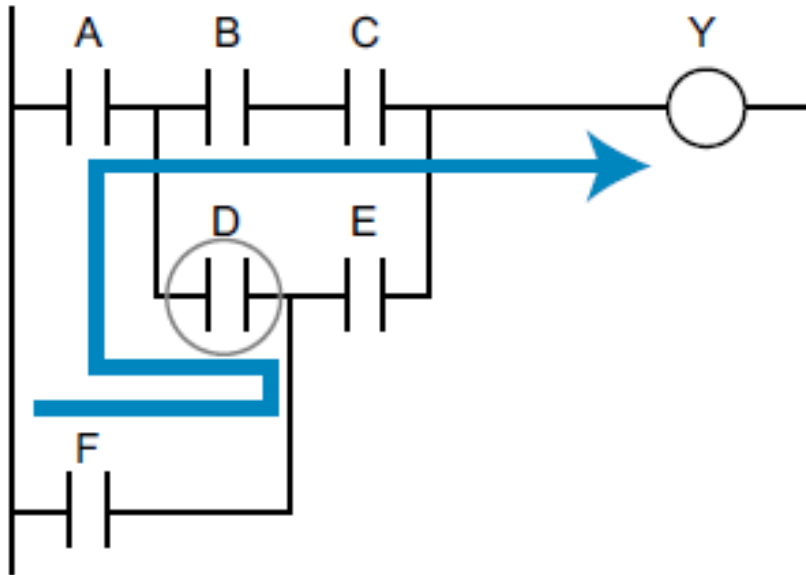
Not allowed



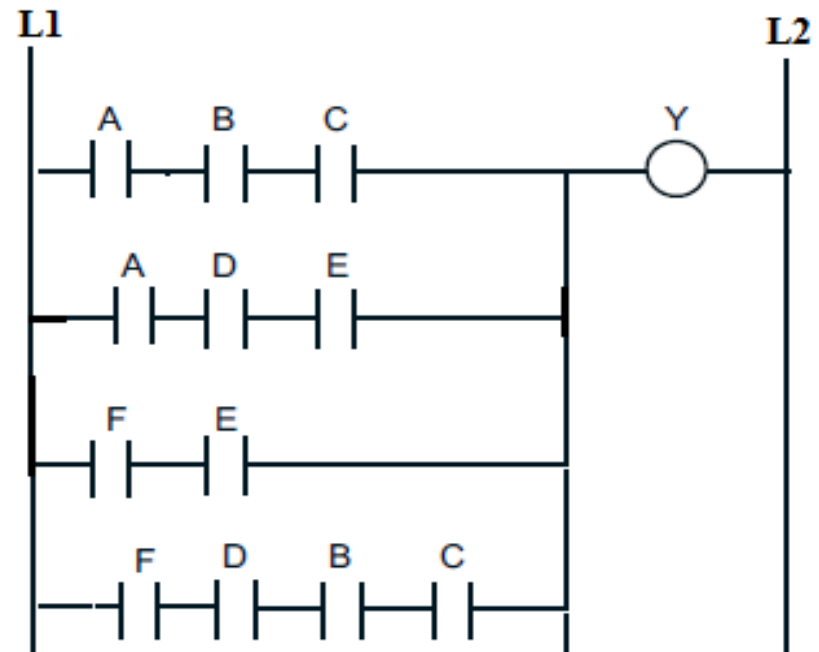
Reprogrammed to obtain the required logic

Programming restrictions

2) Power can never flow from right to left.



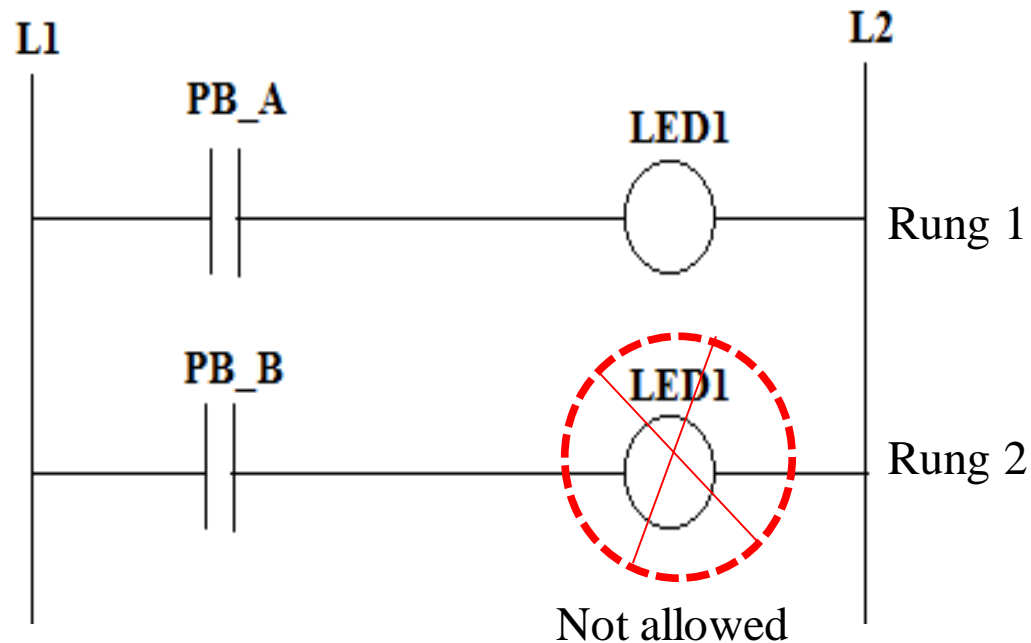
Not allowed



Reprogrammed to obtain the required logic

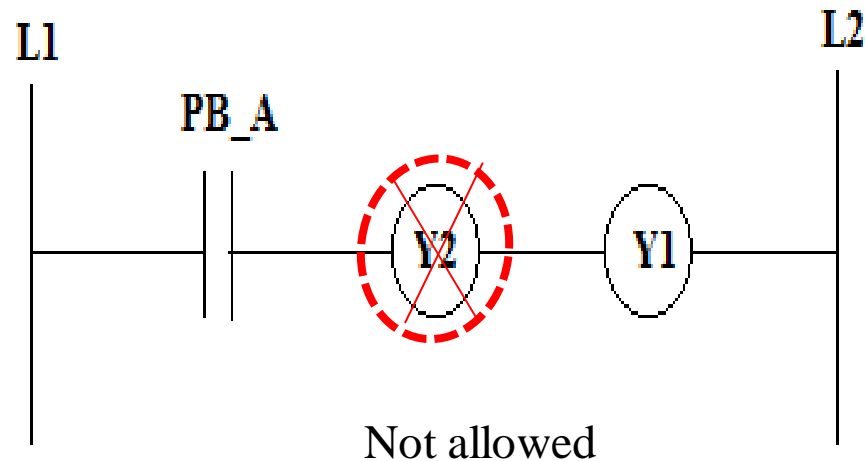
Programming restrictions

- 3) An output referencing a specific real output should appear only once in ladder diagram.



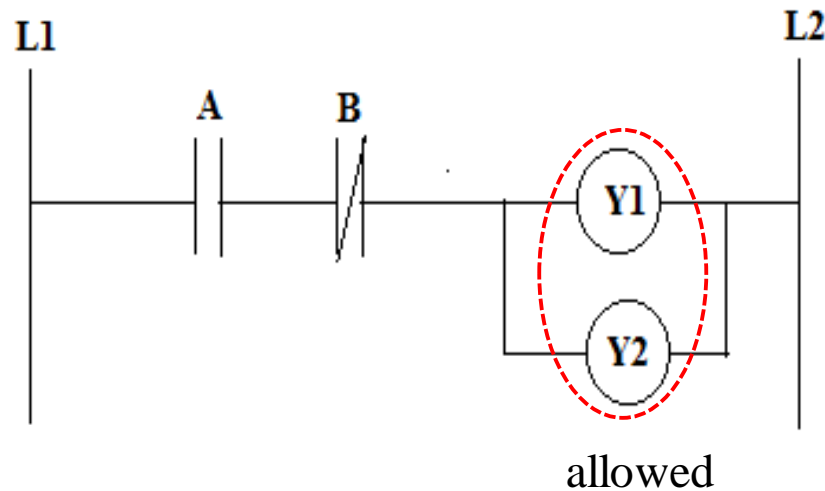
Programming restrictions

- 4) Only one output should appear in a rung of ladder diagram.



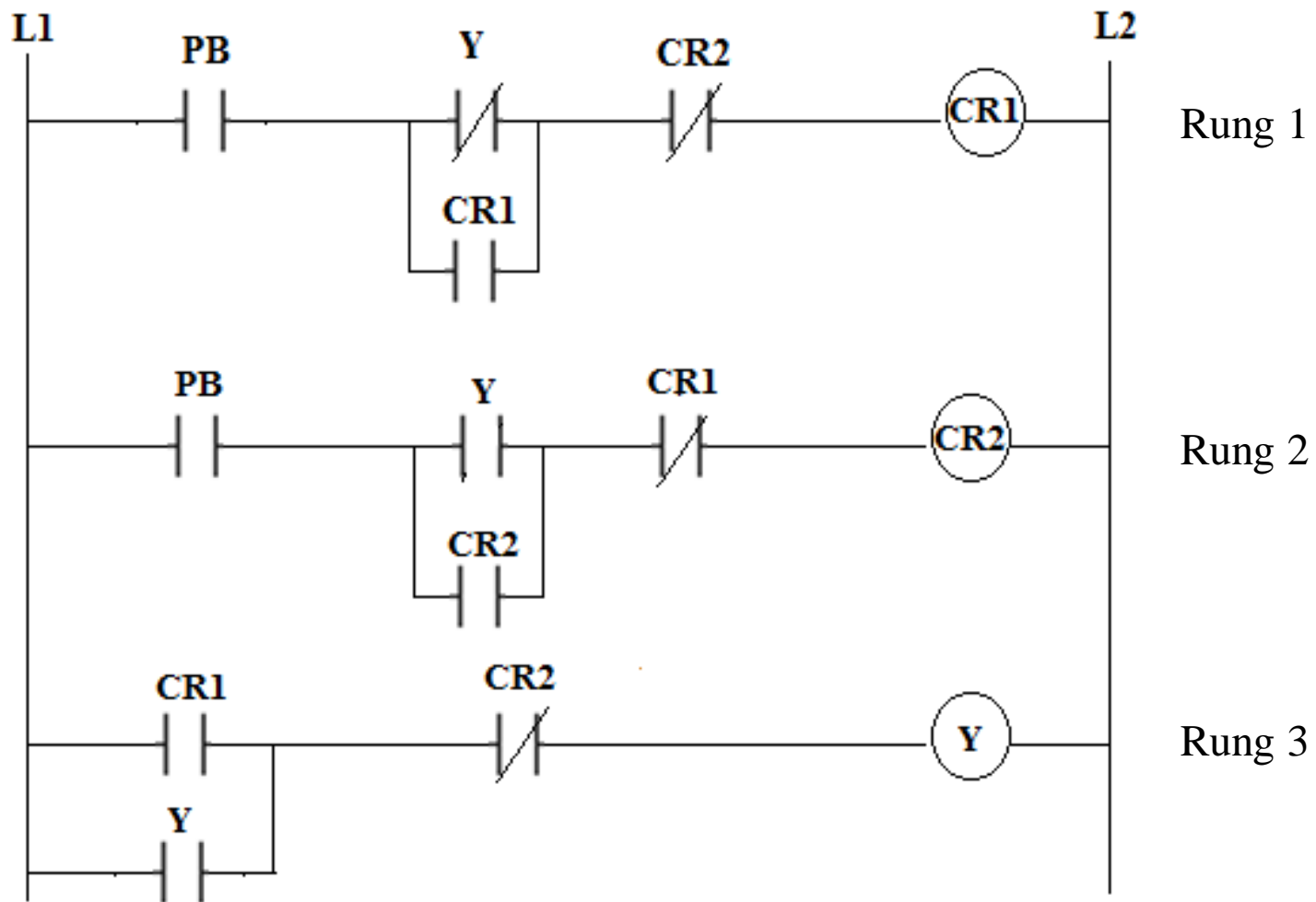
Programming restrictions

- 5) If more than one output is to be controlled by a certain rung of ladder diagram, these outputs can be placed in parallel.



EX1: Single Push Button On/Off Ladder Logic

- This function is also called **push on push off logic** or **toggle function**.
- It is the same function as the on/off button on your computer or mobile phone. When you push the button the first time, the output will be activated. Now, when you push the button for the second time, the output will deactivate and turn off.
- The single push button has two functions: on and off.



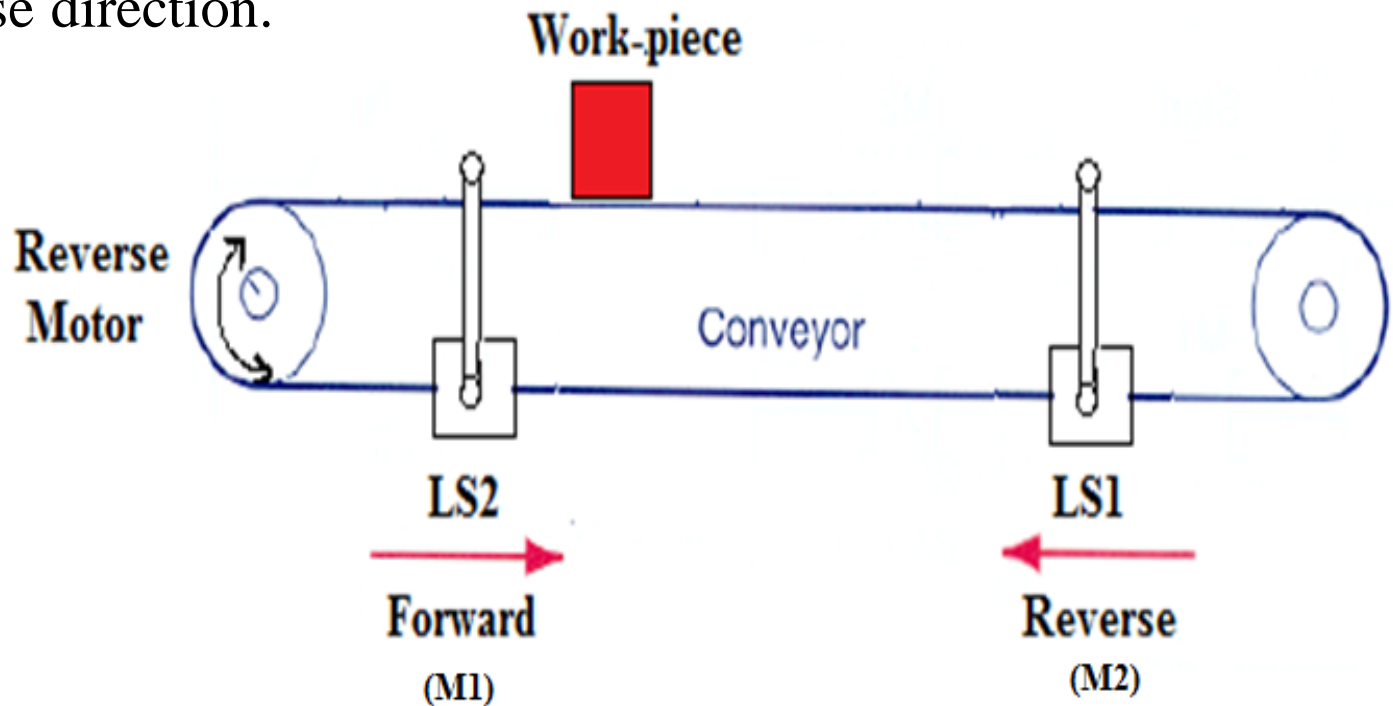
Ladder diagram for single push button on/off

EX2: Reciprocating Motion

- A work-piece is loaded on a conveyor belt, it is required to design a ladder diagram program to do the following operations:
 - 1) First, the start button is pressed and the motor motion is in the forward direction.
 - 2) When the limit switch LS1 is activated (the work-piece position is at LS1), the motor motion is reversed and the conveyor moves in the opposite direction.
 - 3) When the limit switch LS2 is activated (the work-piece position is at LS2), the motor motion is returned to the forward direction.

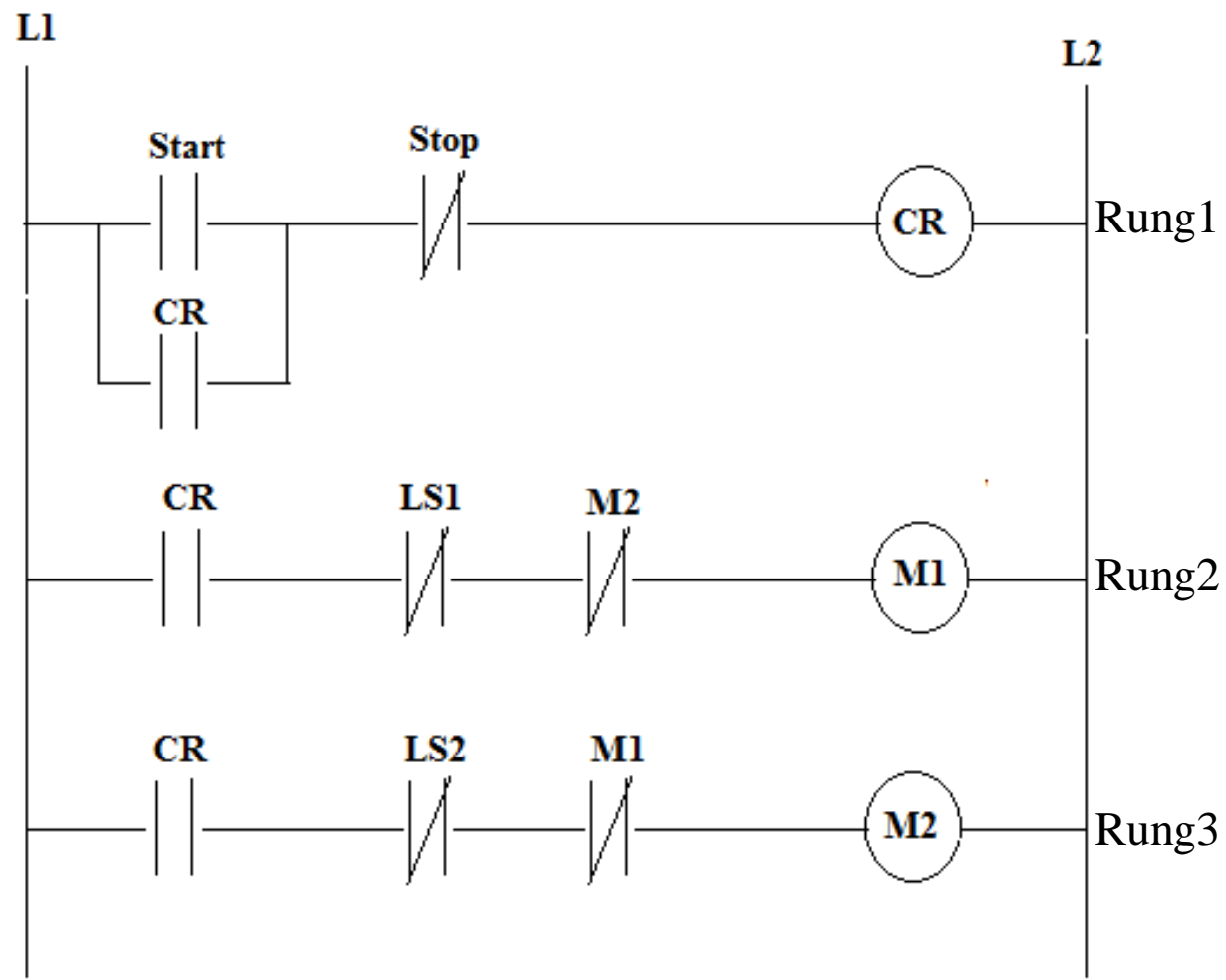
EX2: Reciprocating Motion

- 4) Steps 2) and 3) is repeated until the stop button is pressed.
- 5) Pressing the stop button stops the motor motion in forward or reverse direction.



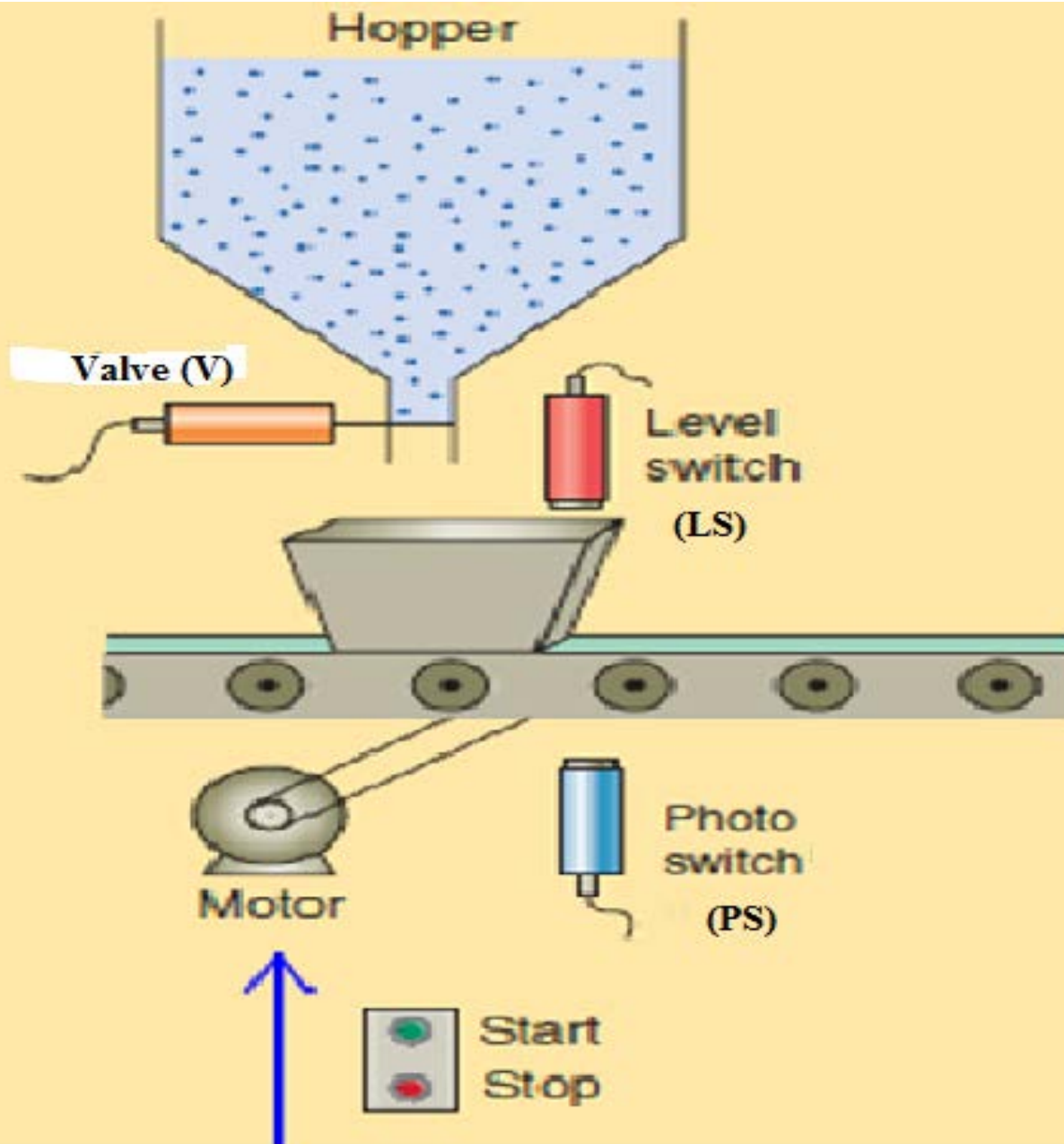
- We need the following inputs and outputs :

Label	I/O
Start (NO Push button switch)	Inputs
Stop (NC Push button switch)	
LS1 (NC limit switch)	
LS2 (NC limit switch)	
M1 (Motor Forward Motion)	Outputs
M2 (Motor Reverse Motion)	
CR	Internal relay / Internal output



EX3: Production Line

- Write a ladder diagram program for a production line that detects the position of a bottle via a photo-sensor (**PS**) which stops the motor (**M**) motion and opens the valve (**V**) to fill the bottle until a level switch (**LS**) detects a filled condition.
- After the bottle is filled, the motor moves again and to repeat these operation to the next bottle and son.
- The production line should include start and stop push button switches.



- We need the following inputs and outputs :

Label	I/O
Start (NO Push button switch)	Inputs
Stop (NC Push button switch)	
LS (NC Level switch)	
PS (NC Photo sensor)	
M (Motor)	Outputs
V (Valve)	
CR	Internal relay / Internal output

